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Copepoda from deep-sea hydrothermal vents at the East Pacific Rise

by Arthur G. Humes

Abstract. — During the HYDRONAUT cruise in 1987 at the East Pacific Rise, between 12°45′ N and 12°50′ N in a depth of 2,630 m, 18 species of copepods (Poecilostomatoida and Siphonostomatoida) were collected. These include 3 new siphonostomatoids : *Cheramomyzon abyssale* n. gen., n. sp., *Aphotopontius hydronauticus* n. sp., and *Benthoxynus tumidiseta* n. sp.; and 15 species already known from other regions : *Oncaea praeclara, Aphotopontius arcuatus, A. mammillatus, Ceuthoecetes aliger, C. cristatus, Exrima dolichopus, Nilva torifera, Rhogobius contractus, Scotoecetes introrsus, Stygiopontius appositus, S. cinctiger, S. hispidulus, S. sentifer, S. stabilitus*, and *Ecbathyrion prolixicauda.*

Résumé. — Pendant la campagne HYDRONAUT en 1987 sur la Ride Pacifique Est, entre 12°45′ N et 12°50′ N à une profondeur de 2 630 m, 18 espèces de copépodes (Poecilostomatoida et Siphonostomatoida) ont été recueillies. Elles comprennent 3 siphonostomatoïdes nouveaux : *Cheramomyzon* n. gen., n. sp., *Aphotopontius hydronauticus* n. sp., et *Benthomyzon tumidiseta* n. sp., et 15 espèces déjà connues d'autres régions : *Oncaea praeclara, Aphotopontius arcuatus, A. mammillatus, Ceuthoecetes aliger, C. cristatus, Exrima dolichopus, Nilva torifera, Rhogobius contractus, Scotoecetes introrsus, Stygiopontius appositus, S. cinctiger, S. hispidulus, S. sentifer, S. stabilitus*, et *Ecbathyrion prolixicauda.*

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Since the discovery in 1977 of an abundant fauna at deep-sea hydrothermal vents on the Galapagos Rift (Corliss and Ballard, 1977), numerous copepods from vents have been reported (Fleminger, 1983; Humes, 1984, 1987, 1988*a, b, c*, 1989*a, b*; Humes and Dojiri, 1980). Vent areas thus far prospected include the Galapagos Rift, the East Pacific Rise at 13° N and 21° N, the Guaymas Basin in the lower Gulf of California, the Juan de Fuca spreading zone off the coast of Washington, the Mariana Back-Arc Basin, and the mid-Atlantic Ridge at 23° and 26° N (Humes, 1984, 1987, in press; Mevel *et al.*, 1989).

In this paper 18 species of copepods are reported from the East Pacific Rise at approximately 13° N, 104° W, all in a depth of 2,630 m. Three new species of Siphonostomatoida, including one new genus, are described. New records are given for 15 previously described species, with the ranges of seven of these extended.

Materials and methods

The material analyzed in this study was collected by the submersible "Nautile" during the HYDRONAUT cruise 1987 aboard N/O "Nadir", organized by IFREMER DERO/EP (chief scientist : A. M. Alayse), and was sorted by the Centre National de Tri d'Océanographie Biologique (CENTOB), Brest.

All specimens were studied and measured in lactic acid, using the wooden slide technique described by Humes and Gooding (1964). The length of the body does not include the setae on the caudal rami. The segments of the first antenna were measured along their posterior nonsetiferous margins. In the formulas for the armature of the legs, Roman numerals represent spines, Arabic numerals indicate setae. All drawings were made with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. Abbreviations used on the figures are : A_1 = first antenna, A_2 = second antenna, MD = mandible, MX_1 = first maxilla, MX_2 = second maxilla, MXPD = maxilliped, and P_1 = leg. 1.

The sites where copepods were found are referred to by the names Genesis, Parigo, Totem, Julie, and Elsa. All collections were made in the year 1987 in a depth of 2,630 m.

Order POECILOSTOMATOIDA Thorell, 1859

Family Oncaeidae Giesbrecht, 1892

Oncaea praeclara Humes, 1988

Specimens examined. — 3 ♀♀, 1 ♂, Julie, East Pacific Rise, 12°48.96′ N, 103°56.62′ W, "Nautile" dive no. 203, 25 October; 19 ♀♀, 6 ♂♂, 1 ♀ and 1 ♂ in amplexus, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November; 1 ♂, Genesis, EPR, "Nautile" dive no. 208, 10 November; 13 ♀♀, 6 ♂♂, Genesis, EPR, "Nautile" dive no. 222, 23 November; 1 ♀, Totem, EPR, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 212, 06 December; 11 ♀♀, 1 ♂, Parigo, EPR, 12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 227, 29 November; 5 ♀♀, 5 ♂♂, Parigo, EPR, "Nautile" dive no. 221, 22 November.

Previous distribution. — Galapagos Rift, East Pacific Rise at 21° N, Guaymas Basin (Gulf of California) (Humes, 1988*c*).

Order SIPHONOSTOMATOIDA Thorell, 1859

Family Asterocheridae Giesbrecht, 1899

CHERAMOMYZON n. gen.

Diagnosis. — Family Asterocheridae. Subfamily Asterocherinae (see Ummerkutty, 1966). Female. Body unmodified. Epimera of metasomal segments not acutely pointed. Cephalosome with submarginal ventral internal lobes. Rostrum small. First antenna 19-segmented, with small spine on segment 10 and

aesthete on segment 17. Second antenna with 1-segmented exopod. Oral cone short. Mandible with 2-segmented palp. First maxilla with 4 setae on outer lobe, 5 setae on inner lobe. Second maxilla with 1 segment plus long claw. Maxilliped 5-segmented. Legs 1-4 with 3-segmented rami, second segment of endopods having 2 setae. Legs 3 and 4 with third segment of endopod having terminal spine. Leg 5 2-segmented, distal segment with 4 setae. Male unknown.

TYPE SPECIES. — *Cheramomyzon abyssale* n. sp.

GENDER. — Neuter.

ETYMOLOGY. — The generic name is derived from the Greek words *cheramos*, a cleft, alluding to the habitat at hydrothermal vents, and *myzo*, to suck, referring to the probable method of feeding of this siphonostome.

REMARKS

The new genus is related to both *Dermatomyzon* Claus, 1889, and *Rhynchomyzon* Giesbrecht, 1895. Similarities between *Cheramomyzon* and these two genera may be seen in the antennae, the mouthparts, the armature of legs 1-4, and the segmentation of the urosome. Differences, based on females and adapted from EISELT (1965 : 159), SARS (1915 : 98-100), and SEWELL (1949 : 49), are as follows :

	Dermatomyzon	*Rhynchomyzon*	*Cheramomyzon*
Epimera of prosome	rounded	pointed	bluntly pointed
Rostrum	small	large, beaklike	small
Number of segments in A_1	14-19	13-20	19
Palp of mandible	1-segmented	1-segmented	2-segmented
Number of setae on distal segment of leg 5	5	2, 3, or 5	4
Internal ventral lobes on edges of cephalosome	absent	absent	present

Cheramomyzon abyssale n. sp.

(Figs 1-3)

TYPE MATERIAL. — 8 ♀♀, in 2,630 m, Genesis and Parigo, East Pacific Rise, 12°48.56′ N, 103°56.48′ W and 12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November 1987. Holotype (Cp 364) and 7 paratypes (Cp 365) deposited in the Muséum national d'Histoire naturelle, Paris.

OTHER SPECIMENS. — 2 ♀♀, Parigo, East Pacific Rise, 12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 222, 23 November; 1 ♀, Elsa, EPR, 12°48.09′ N, 103°56.34′ W, 29 November.

FEMALE

Body (fig. 1a, b) with moderately slender prosome. Length 2.14 mm (2.09-2.27 mm) and greatest width 0.66 mm (0.63-0.67 mm), based on 6 specimens. Greatest dorsoventral thickness 0.37 mm. Segment bearing leg 1 fused with cephalosome. Epimera of segments bearing legs 1-3 bluntly pointed, those of segment bearing leg 4 more pointed. Cephalosome having

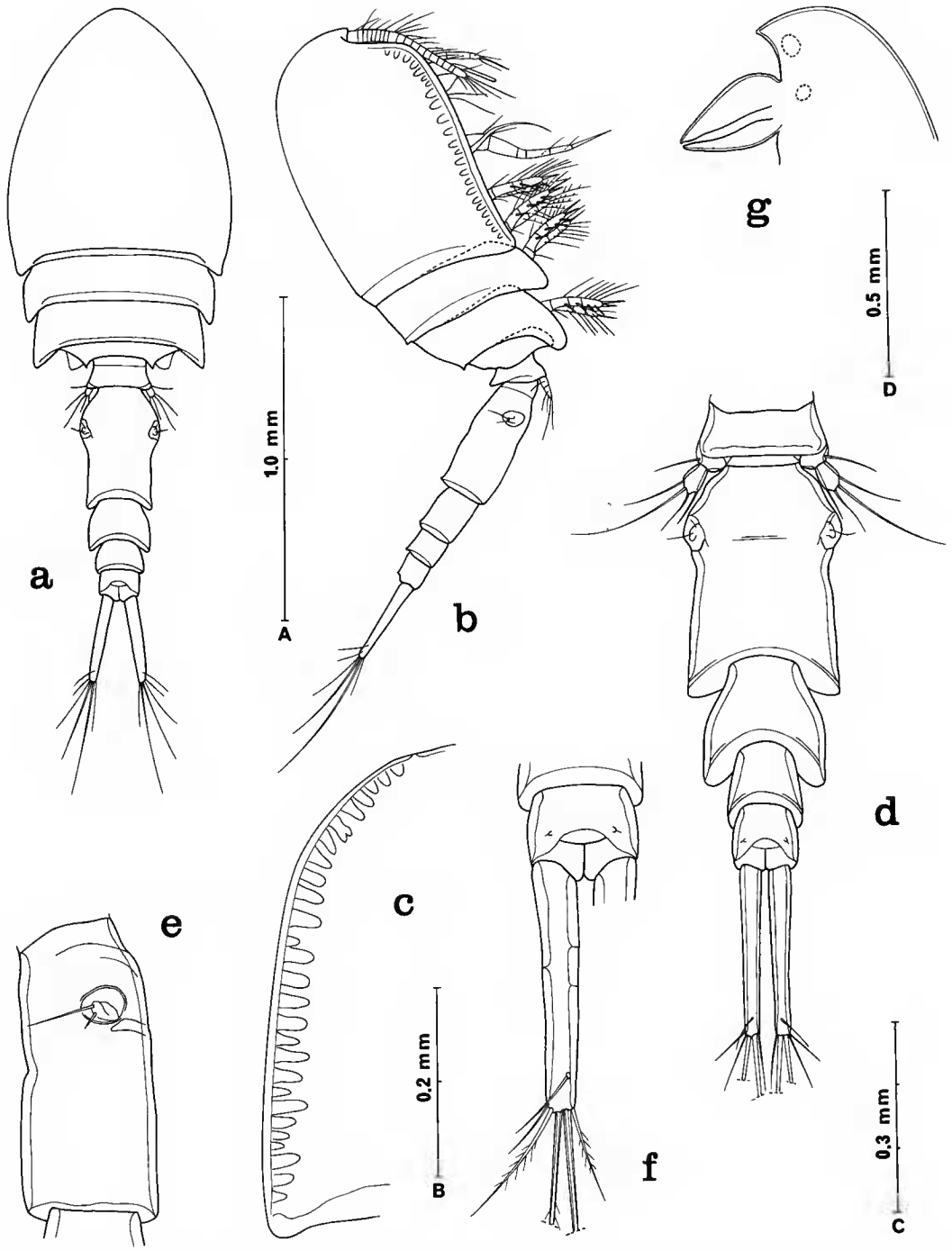

FIG. 1. — *Cheramomyzon abyssale* n. gen., n. sp., female : a, dorsal (scale A); b, lateral (A); c, edge of cephalosome, ventral (B); d, urosome, dorsal (C); e, genital segment, lateral (B); f, anal segment and caudal ramus, dorsal (B); g, outline of rostrum and oral cone, lateral (D).

submarginal row of conspicuous internal digitiform lobes of varying sizes (fig. 1c). Ratio of length to width of prosome 1.59 : 1. Ratio of length of prosome to that of urosome 1.13 : 1.

Segment bearing leg 5 (fig. 1d) broad, 91 × 198 μm. Genital segment elongate, in dorsal view 330 μm long, 240 μm wide at slight lateral expansions in anterior third, and 214 μm wide in posterior two-thirds with nearly parallel sides but slightly wider posteriorly than anteriorly. In lateral view (fig. 1e) slight notch in dorsal surface. Genital areas situated anteriorly. Each area (fig. 1e) with 2 unequal setae 90 μm and 12 μm. Three postgenital segments from anterior to posterior 165 × 187 (expanded laterally in dorsal view), 104 × 130, and 91 × 109 μm.

Caudal ramus (fig. 1f) elongate, slender, 270 × 34 μm, ratio 8 :1. Outer lateral seta 52 μm, dorsal seta 70 μm, both smooth. Outermost terminal seta 156 μm, innermost terminal seta 117 μm, and 2 long median terminal setae 380 μm (outer) and 440 μm (inner), both with lateral setules along midregions.

Body surface unornamented except for pair of sensilla on dorsal surface of anal segment (fig. 1d).

Egg sac containing single egg. Eggs in all ovigerous specimens damaged but estimated diameter 190 μm.

Rostrum (fig. 1g) small. First antenna (fig. 2a) 528 μm long, 19-segmented. Lengths of segments : 42 (78 μm along anterior margin), 16, 16, 16, 16, 16, 16, 19, 27, 17, 26, 26, 34, 39, 36, 34, 48, 14, and 60 μm, respectively. Formula for armature : 2, 2, 2, 2, 2, 2, 2, 2, 7, 1 + small spine 8 μm long, 2, 2, 2, 2, 2, 2, 2 + 1 aesthete, 2, and 20. All setae smooth. Two females with segment 9 showing ventral sclerotization suggesting division into 2 segments (fig. 2b).

Second antenna (fig. 2c) 275 μm long, slender. Coxa short, basis elongate. Exopod 1-segmented, 15.5 × 5 μm, with 3 small setae. Endopod with first segment having outer row of setules. Second segment only one-half length of first segment, bearing 1 inner marginal seta, 2 unequal terminal setae (longer seta 154 μm), 2 very unequal subterminal outer setae, and 1 outer marginal setule. All setae smooth.

Oral cone (fig. 1g) short, in posterior view showing minute terminal setules (fig. 2d). Mandible (fig. 2e) with long slender blade 270 μm, bearing row of several small teeth distally (fig. 2f). First maxilla (fig. 2g) with both lobes elongate and slender, outer lobe with 4 long smooth setae, inner lobe with 5 smooth setae and having row of setules on inner margin. Second maxilla (fig. 2h) with long slender segment and recurved terminal claw 250 μm long bearing 1 seta almost midway. Maxilliped (fig. 2i) 5-segmented, slender. First segment with 1 distal inner seta. Second segment with row of setules on outer side. Small third segment short and obscure, with 2 small setae (fig. 3a). Elongate slender fourth segment with 1 distal seta. Similarly elongate fifth segment with 1 distal seta and 1 terminal straight smooth claw 122 μm.

Legs 1-4 (fig. 3b-e) with 3-segmented rami. Formula for armature as follows :

P_1	coxa 0-1	basis 1-1	exp I-1;	I-1;	II,I,5
			enp 0-1;	0-2;	1,2,3
P_2	coxa 0-1	basis 1-0	exp I-1;	I-1;	II,II,5
			enp 0-1;	0-2;	1,2,3
P_3	coxa 0-1	basis 1-0	exp I-1;	I-1;	II,II,4
			enp 0-0;	0-2;	1,I,3
P_4	coxa 0-1	basis 1-0	exp I-1;	I-1;	II,II,4
			enp 0-1;	0-2;	1,I,2

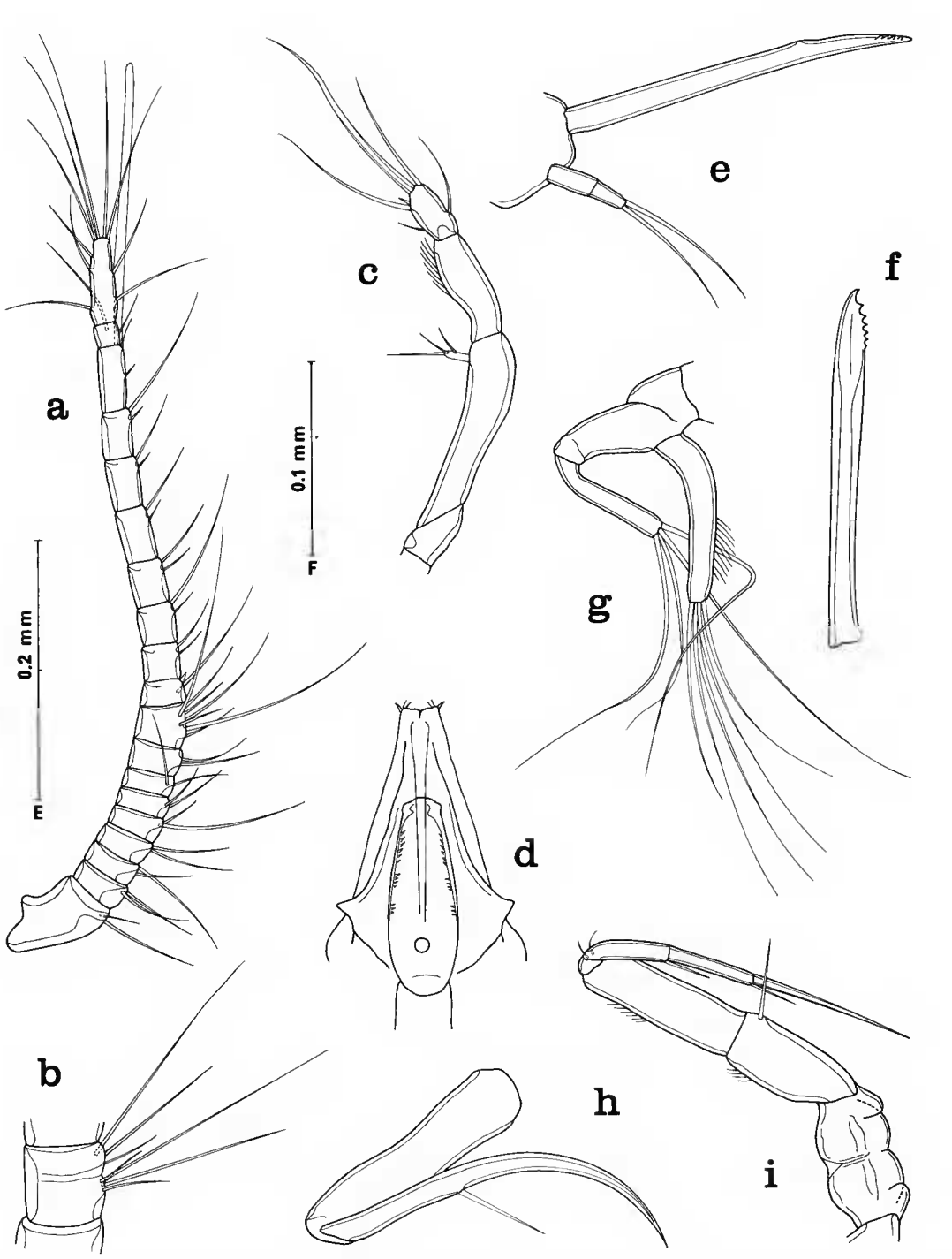

FIG. 2. — *Cheramomyzon abyssale* n. gen., n. sp., female : a, first antenna, dorsal (scale E); b, segment 9 of first antenna, ventral (F); c, second antenna, antero-outer (E); d, oral cone, posterior (B); e, mandible, anterior (E); f, blade of mandible, flat view (E); g, first maxilla, anterior (E); h, second maxilla, anterior (E); i, maxilliped, posterior (E).

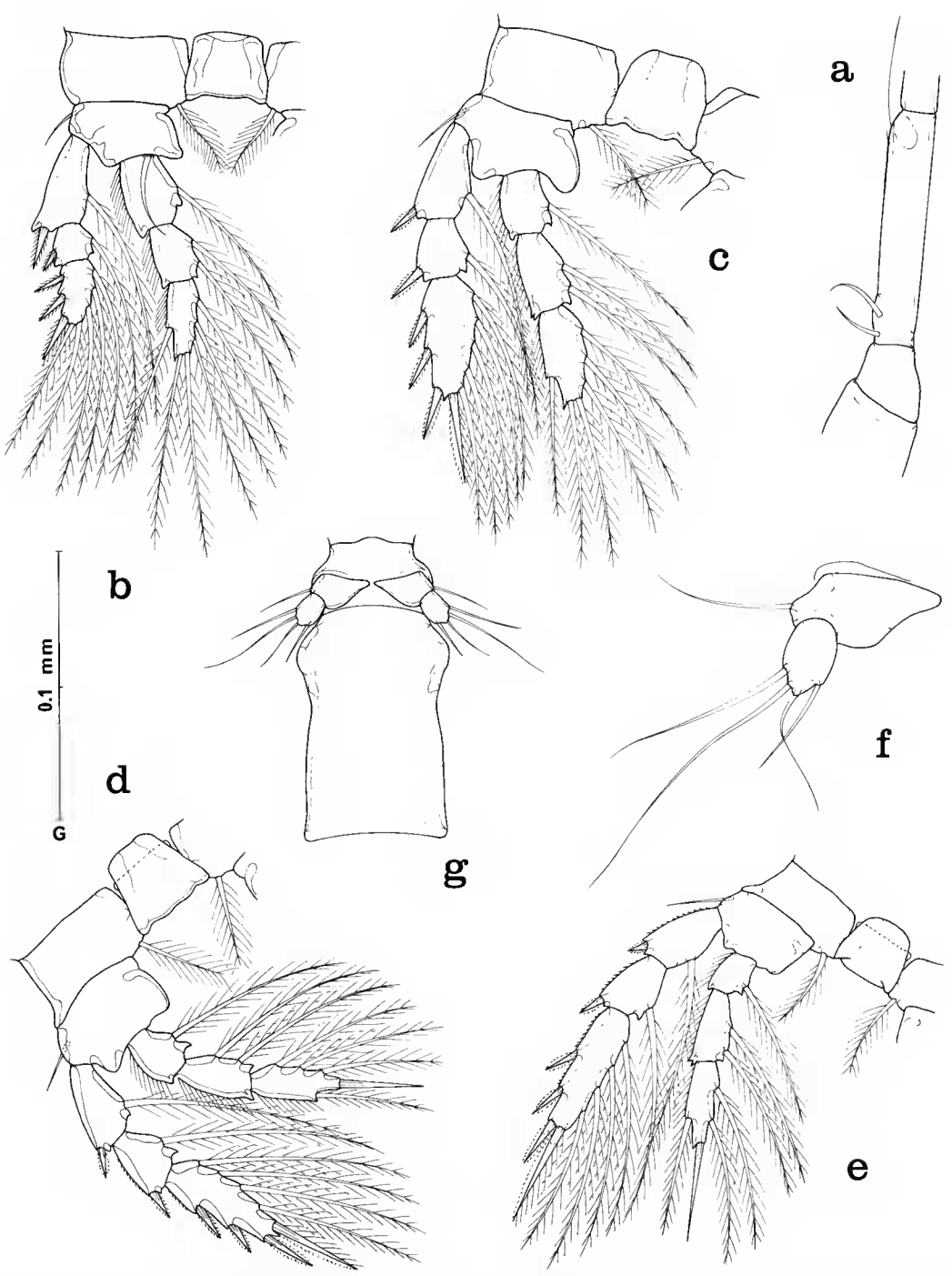

FIG. 3. — *Cheramomyzon abyssale* n. gen., n. sp., female : a, segments 3 and 4 of extended maxilliped, antero-outer (scale G); b, leg 1 and intercoxal plate, anterior (B); c, leg 2 and intercoxal plate, anterior (B); d, leg 3 and intercoxal plate, anterior (B); e, leg 4 and intercoxal plate, anterior (B); f, leg 5, lateroventral (E); g, leg 5 and genital segment, ventral (C).

Basis of leg 1 with inner seta 80 μm long and smooth, with few minute spinules near its insertion. Terminal spine on endopods of legs 3 and 4 smooth. One female with left endopod of leg 4 having 0-1; 0-1; 1,I,2. Rami of all legs strongly sclerotized.

Leg 5 (fig. 3f, g) 2-segmented. First segment bearing 1 smooth outer seta 90 μm and extended toward midventral line. Second segment oval, 56 × 34 μm, ratio 1.65 : 1, bearing 4 smooth setae from outer to inner 135, 190, 68, and 84 μm.

Leg 6 represented by 2 setae on genital area (fig. 1e).

Color of living specimens unknown.

MALE. — Unknown.

ETYMOLOGY. — The specific name *abyssale*, an adjectival form made from Latin *abyssus*, an abyss or unfathomable place, alludes to the great depth at which the copepods were found.

Family DIRIVULTIDAE Humes and Dojiri, 1980

Aphotopontius arcuatus Humes, 1987

SPECIMENS EXAMINED. — 6 ♀♀, 1 ♂, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 212, 06 November; 44 ♀♀, 1 ♂, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 208, 10 November; 1 ♀, Genesis, EPR, "Nautile" dive no. 222, 23 November.

PREVIOUS DISTRIBUTION. — Galapagos Rift, East Pacific Rise at 13° N and 21° N (HUMES, 1987).

Aphotopontius hydronauticus n. sp.

(Figs 4, 5)

TYPE MATERIAL. — 59 ♀♀, in 2,630 m, Genesis, East Pacific Rise, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 225, 27 November 1987. Holotype (Cp 366), and 56 paratypes (Cp 367) deposited in the Muséum national d'Histoire naturelle, Paris.

OTHER SPECIMENS. — 2 ♀♀, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November; 18 ♀♀, Genesis, EPR, "Nautile" dive no. 221, 22 November; 10 ♀♀, Genesis, EPR, "Nautile" dive no. 216, 10 November; 32 ♀♀, Genesis, EPR, "Nautile" dive no. 208, 10 November.

FEMALE

Body (fig. 4a) moderately slender. Length 1.13 mm (1.06-1.21 mm) and greatest width 0.47 mm (0.44-0.52 mm), based on 10 specimens. Greatest dorsoventral thickness 0.36 mm. Segment bearing leg 1 fused with cephalosome, with only slight lateral indications of boundary. Epimeral areas of segments bearing legs 1 and 2 pointed, those of segment bearing leg 3 truncated, and those of segment bearing leg 4 rounded. Ratio of length to width of prosome 1.58 : 1. Ratio of length of prosome to that of urosome 1.87 : 1.

Segment bearing leg 5 (fig. 4b) 96 × 205 μm, trapezoidal with postero-outer corners

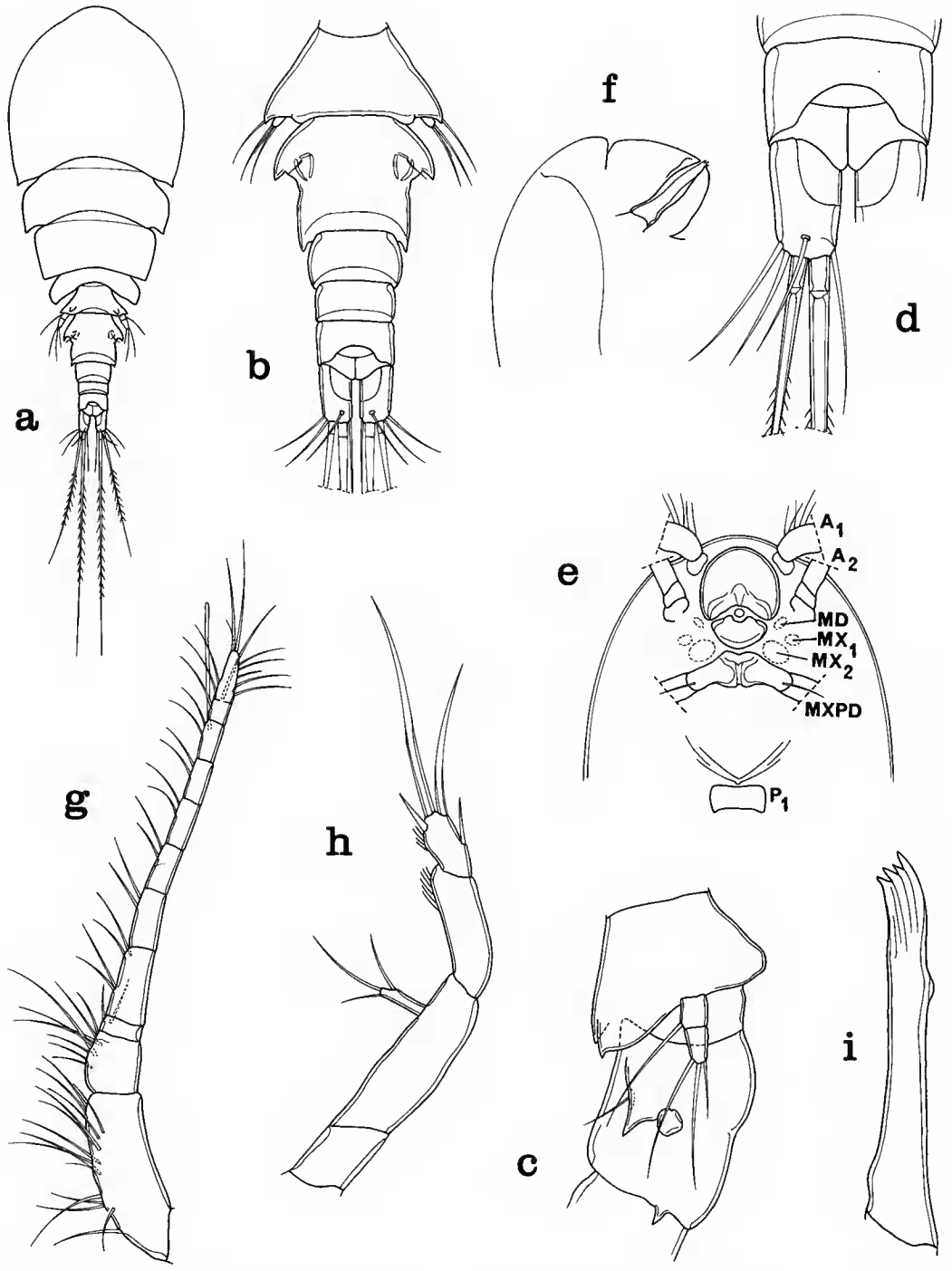

FIG. 4. — *Aphotopontius hydronauticus* n. sp., female : a, dorsal (scale D); b, urosome, dorsal (B); c, segment bearing leg 5 and genital segment, lateral (E); d, anal segment and caudal ramus, dorsal (F); e, cephalosome, ventral (C); f, outline of rostrum and oral cone, lateral (C); g, first antenna, posteroventral (E); h, second antenna, antero-inner (F); i, mandible, anterior (G).

pointed and having pair of posterior marginal processes (fig. 4b, c). Genital segment broad, 130 μm long, 174 μm wide at conspicuous lateral spiniform processes in anterior half, abruptly narrower posteriorly, 122 μm wide, ending in smaller posterolateral spiniform processes. Openings of oviducts located dorsolaterally just anterior to middle of segment and bearing slender seta 30 μm. Openings of seminal receptacles situated lateroventrally near middle of segment (fig. 4b, c). Three postgenital segments from anterior to posterior 60 × 104, 44 × 91, and 50 × 81 μm.

Caudal ramus (fig. 4d) short, 60 × 34 μm, ratio 1.77 : 1 (width taken at middle). Outer lateral seta 68 μm, dorsal seta 60 μm, outermost terminal seta 57 μm, and innermost terminal seta 83 μm, all smooth. Two long median terminal setae 385 μm (outer) and 620 μm (inner) with short lateral setules.

Body surface smooth, without visible sensilla.

Egg sac not seen.

Rostral area (fig. 4f) not well developed, projecting only slightly. First antenna (fig. 4g) 429 μm long, not including setae. Lengths of its 10 segments : 91 (127 μm along anterior margin), 34, 13, 49, 39, 34, 34, 31, 31, and 52 μm. Terminal segment showing suggestion of division. Formula for armature : 15, 8, 2, 4, 2, 2, 2, 2, 2 +1 aesthete, and 12. All setae smooth.

Second antenna (fig. 4h) 190 μm long without setae. Exopod slender, 21 × 5 μm, and bearing 3 setae. First segment of endopod with distal outer marginal setules. Second segment with 4 setae, 2 long and stout, 2 short and slender, longest seta 105 μm; few setules on outer margin of segment.

Oral cone (fig. 4e, f) short, stout, with mandibles fitted between labrum and labium. Mandible (fig. 4i) 135 μm long. First maxilla (fig. 5a) with relatively small outer lobe bearing 3 setae and larger inner lobe with 4 terminal setae and row of prominent long setules on inner margin. Second maxilla (fig. 5b) and maxilliped (fig. 5c) as in congeners, for example, *Aphotopontius forcipatus* Humes, 1987. Claw of maxilliped 107 μm long.

Ventral area between maxillipeds and first pair of legs (fig. 4e) only slightly protuberant.

Legs 1-4 (fig. 5d-g) with 3-segmented rami, except endopod 2-segmented in leg 4. Formula of armature as follows :

P_1	coxa 0-1	basis I-1	exp I-1;	I-1;	II,I,4
			enp 0-1;	0-2;	1,2,3
P_2	coxa 0-1	basis 1-0	exp I-1;	I-1;	II,II,4
			enp 0-1;	0-2;	1,2,3
P_3	coxa 0-1	basis 1-0	exp I-1;	I-1;	II,II,5
			enp 0-1;	0-2;	1,I,3
P_4	coxa 0-0	basis 1-0	exp I-1;	I-1;	II,II,4
			enp 0-1;	I-1	

Basis of leg 1 with slender inner spine 40 μm long. Leg 4 with exopod 208 μm. Endopod (fig. 5h) 96 μm, first segment 40 × 18 μm, its plumose inner seta 75 μm, second segment 56 × 17 μm (60 μm long including process), its barbed spine 96 μm, its subterminal inner plumose seta 120 μm.

Leg 5 (fig. 5i) 2-segmented, situated ventrally, first segment 27 × 21 μm, its outer seta 92 μm, second segment 34 × 14 μm, its 3 terminal setae from outer to inner 94, 90, and 35 μm. All setae smooth.

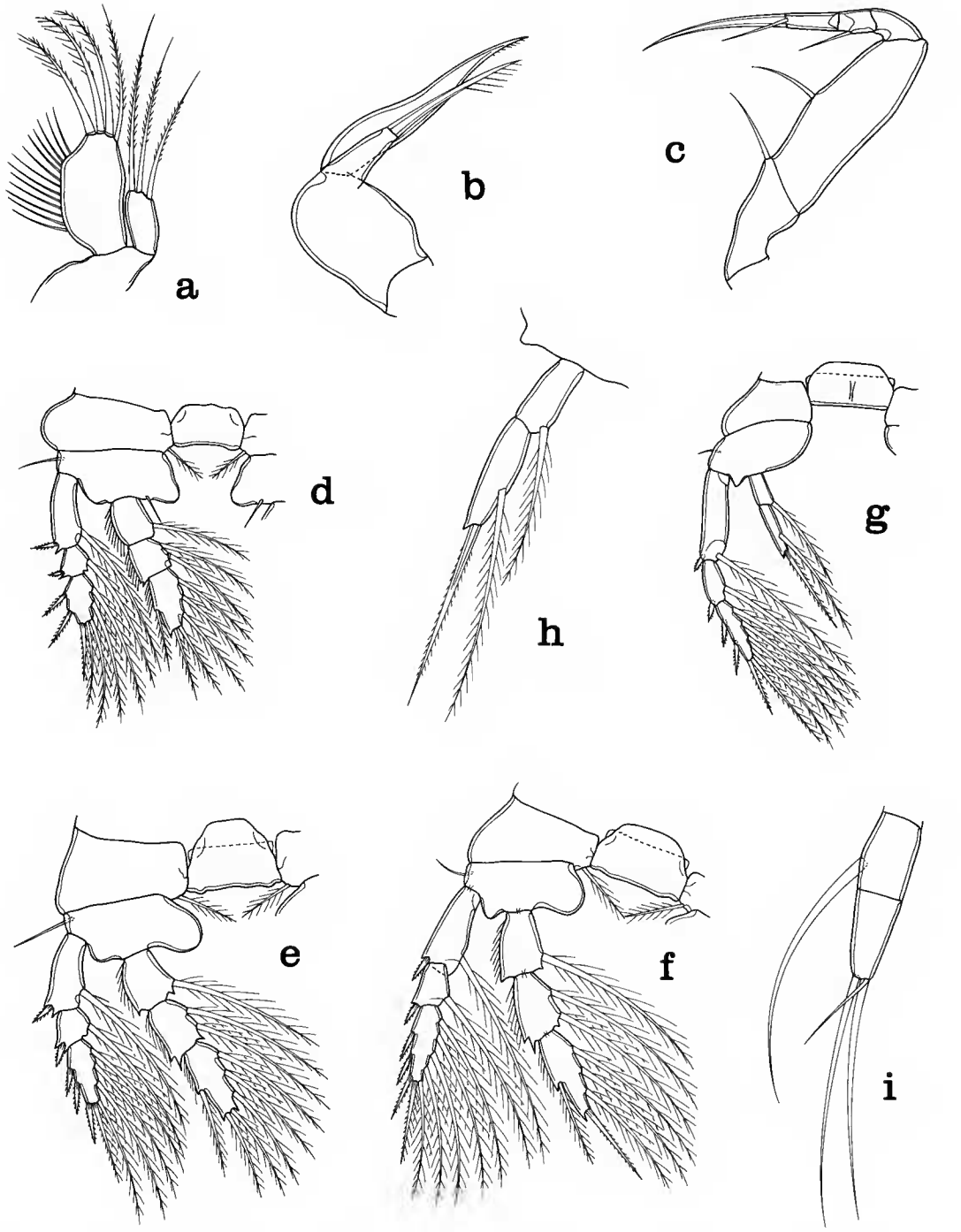

FIG. 5. — *Aphotopontius hydronauticus* n. sp., female : a, first maxilla (scale (F); b, second maxilla, posterior (F); c, maxilliped, posterior (F); d, leg 1 and intercoxal plate, anterior (B); e, leg 2 and intercoxal plate, anterior (B); f, leg 3 and intercoxal plate, anterior (B); g, leg 4 and intercoxal plate, anterior (B); h, endopod of leg 4, anterior (F); i, leg 5, ventral (G).

Leg 6 represented by seta near opening of oviduct (fig. 4b, c).
Color of living specimens unknown.

MALE. — Unknown.

ETYMOLOGY. — The specific name *hydronauticus* alludes to the name of the cruise during which the copepods were collected.

REMARKS

Aphotopontius hydronauticus differs from all six congeners in a combination of its greater body length and its shorter caudal ramus. *Aphotopontius limatulus* Humes, 1987, approaches it in the length of the female (0.98-1.11 mm, average 1.00 mm), but the caudal ramus is 10 : 1, much longer than in the new species. *Aphotopontius arcuatus* Humes, 1987, is the only congener with the genital segment having pronounced lateral spiniform processes, suggesting the condition in the new species. In *A. arcuatus*, however, the caudal ramus of the female is 6.5 : 1. Only two congeners, *A. flexispina* Humes, 1987, and *A. mammillatus* Humes, 1987, have an inner coxal seta on leg 1, as in *A. hydronauticus*. However, these two species are smaller and in them the shape of the genital segment is very different in lacking lateral spiniform processes.

Aphotopontius mammillatus Humes, 1987

SPECIMENS EXAMINED. — 5 ♀♀, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November; 18 ♀♀, Totem, EPR, "Nautile" dive no. 212, 06 November; 6 ♀♀, Totem, EPR, "Nautile" dive no. 218, 12 November; 1 ♀, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 208, 10 November.

PREVIOUS DISTRIBUTION. — Galapagos Rift, East Pacific Rise at 21°, Guaymas Basin (Gulf of California) (HUMES, 1987).

Benthoxynus tumidiseta n. sp.
(Figs 6, 7)

TYPE MATERIAL. — 20 ♀♀, in 2,630 m, Genesis, East Pacific Rise, 12°48.56′ N, 103°56.48′ W, "Nautile" dive nos. 210 and 225, 27 November 1987. Holotype (Cp 368) and 16 paratypes (Cp 369) deposited in the Muséum national d'Histoire naturelle, Paris.

OTHER SPECIMENS. — 2 ♀♀, Elsa, East Pacific Rise, 12°48.09′ N, 103°56.34′ W, "Nautile" dive no. 226, 28 November; 1 ♀, Totem, EPR, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November, 1 ♀, Totem, EPR, "Nautile" dive no. 218, 12 November.

FEMALE

Body (fig. 6a) fragile, thinly sclerotized, prosome not broadened. Length 1.67 mm (1.53-1.76 mm) and greatest width 0.57 mm (0.53-0.64 mm), based on 10 specimens. Greatest dorsoventral thickness 0.34 mm. Segment bearing leg 1 fused with cephalosome. Epimera of

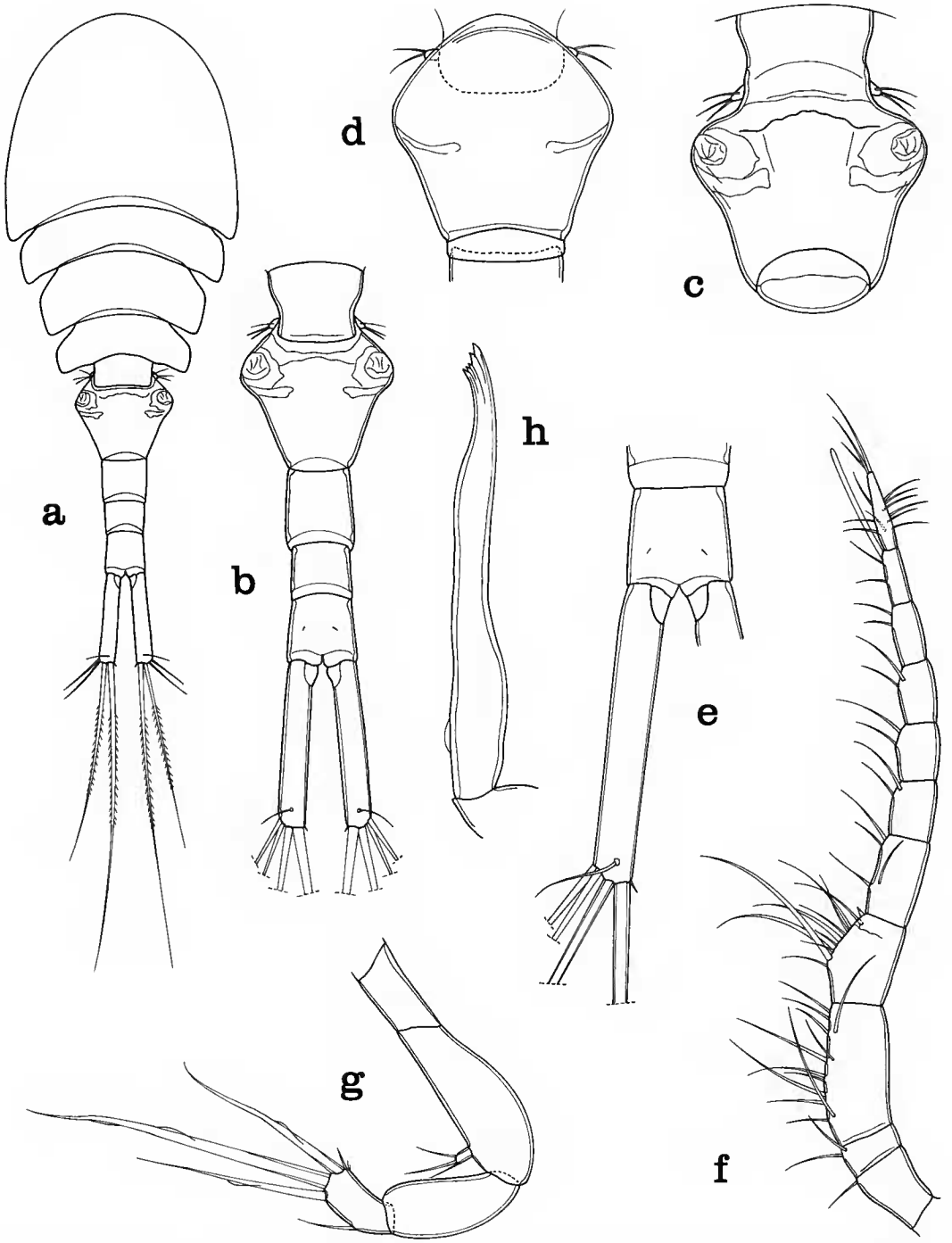

FIG. 6. — *Benthoxynus tumidiseta* n. sp., female : a, dorsal (scale D); b, urosome, dorsal (C); c, segment bearing leg 5 and genital segment, dorsal (B); d, genital segment, ventral (B); e, anal segment and caudal ramus, dorsal (B); f, first antenna, ventral (B); g, second antenna, postero-outer (E); h, mandible, posterior (G).

segment bearing legs 1, 2, and 4 rounded, but those of segment bearing leg 3 truncate. Ratio of length to width of prosome 1.47 : 1. Ratio of length of prosome to that of urosome 1.10 : 1.

Segment bearing leg 5 (fig. 6b) 122 × 133 μm. Genital segment 253 × 242 μm, slightly longer than wide, in dorsal view with rounded lateral expansions in anterior half (fig. 6b-d). Genital areas located dorsolaterally. Each area (fig. 6c) without identifiable seta. Three postgenital segments from anterior to posterior 130 × 110, 83 × 93, and 99 × 99 μm.

Caudal ramus (fig. 6e) elongate, 313 × 45 μm, ratio 7 : 1. Outer lateral seta 107 μm, dorsal seta 78 μm, outermost terminal seta 143 μm, and innermost terminal seta minute, 16 μm. All these setae smooth. Two long median terminal setae 528 μm (outer) and 825 μm (inner), both with short lateral setules along their midregions.

Body surface unornamented except for pair of minute sensilla on dorsal surface of anal segment.

Egg sac not seen.

Rostral area undeveloped as in *Aphotopontius hydronauticus*. First antenna (fig. 6f) 786 μm long, 11-segmented. Lengths of segments : 57 (80 μm along anterior margin), 22, 117, 83, 92, 64, 62, 65, 63, 55, and 82 μm, respectively. Formula for armature : 1, 2, 12, 11, 4, 2, 2, 2, 2, 2 + 1 aesthete, and 13. All setae smooth.

Second antenna (fig. 6g) with small 1-segmented exopod 8 × 5 μm bearing 3 setae. Endopod 2-segmented, first segment unarmed, second segment bearing 1 short seta on inner margin, 1 short terminal outer seta, and 3 long terminal setae with slight spiraling membrane, longest of terminal setae 200 μm.

Oral cone short and stout as in *Aphotopontius hydronauticus*. Mandible (fig. 6h) elongate, 164 μm. First maxilla (fig. 7a) with slender short outer lobe having 4 setae, longer inner lobe with 4 setae and distinct knob on smooth inner edge. Second maxilla (fig. 7b) with second clawlike segment distally pectinate on inner side. Maxilliped (fig. 7c) slender, 5-segmented, fourth segment having 1 seta, fifth segment bearing 1 seta and claw 180 μm long distally pectinate on inner side.

Legs 1-4 (fig.7d-g) with 3-segmented rami, except for 2-segmented endopod in leg 4. Formula for armature as follows :

P_1	coxa 0-0	basis 1-I	exp I-1;	I-1;	III,I,3
			enp 0-1;	0-2;	1,2,3
P_2	coxa 0-0	basis 1-0	exp I-1;	I-1;	II,II,4
			enp 0-1;	0-2;	1,2,3
P_3	coxa 0-0	basis 1-0	exp I-1;	I-1;	II,II,5
			enp 0-0;	0-2;	1,I,3
P_4	coxa 0-0	basis 1-0	exp I-1;	I-1;	II,II,4
			enp 0-0;	1	

Leg 1 with basis having small slender inner spine 26 μm. Second segment of exopod with short inner spine 13 μm. Spines on first and third exopodal segments setiform and recurved. More proximal setae on both rami swollen in basal half. Two outer setae on third endopodal segment slender and short. Outer margins of endopods of legs 1-3 smooth. Leg 2 with outer elements on exopod more spiniform than in leg 1. Leg 4 with exopod 374 μm long. Endopod (fig. 7h) with first segment 108 × 39 μm, second segment 160 × 38 μm, both unornamented; terminal smooth seta 146 μm, swollen proximally and abruptly narrowed distally.

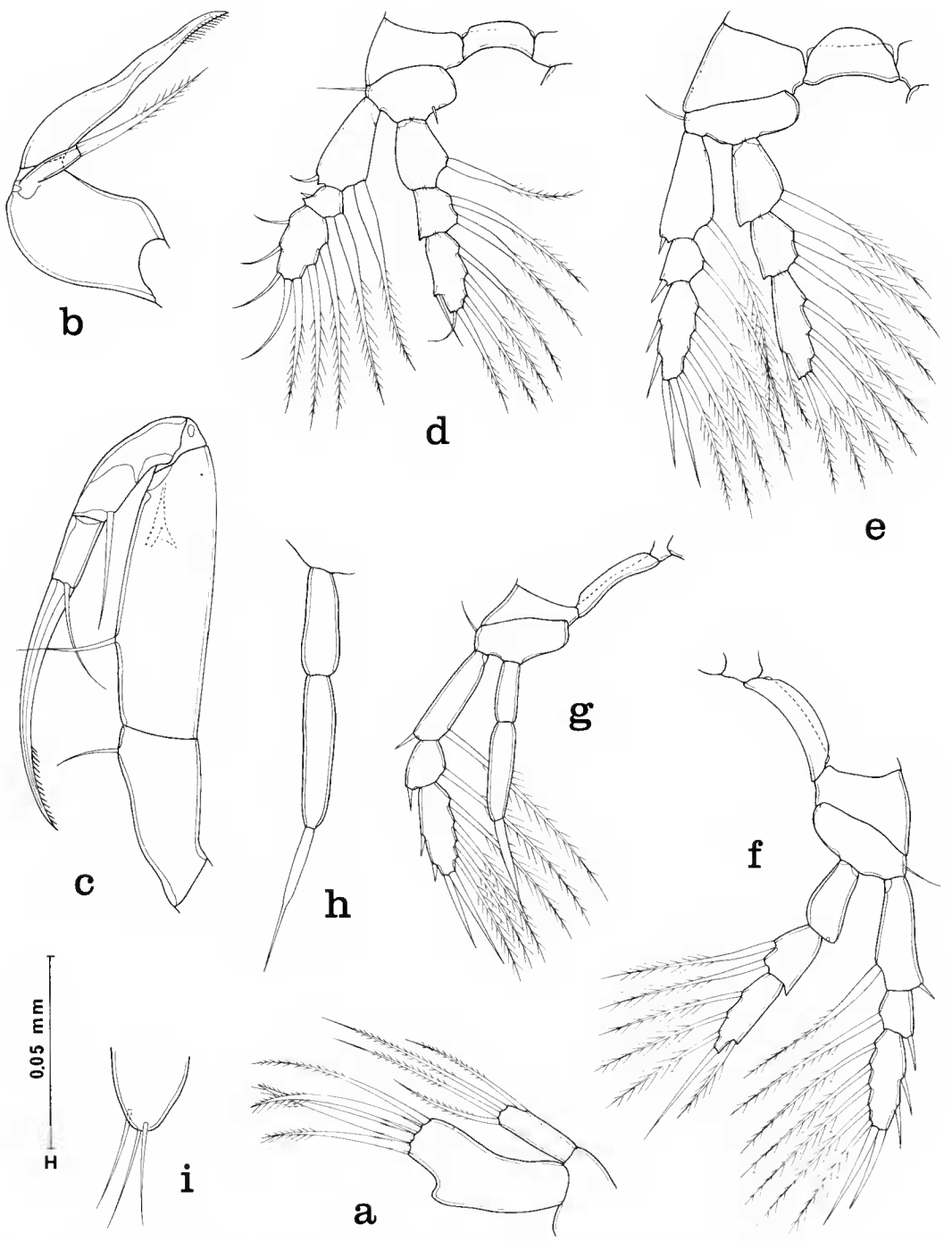

FIG. 7. — *Benthoxynus tumidiseta* n. sp., female : a, first maxilla, posterior (scale F); b, second maxilla, posterior (F); c, maxilliped, posterior (E); d, leg 1 and intercoxal plate, anterior (C); e, leg 2 and intercoxal plate, anterior (C); f, leg 3 and intercoxal plate, anterior (C); g, leg 4 and intercoxal plate, anterior (C); h, endopod of leg 4, posterior (B); i, leg 5, ventral (H).

Leg 5 (fig. 7i) small lobe bearing 3 setae approximately 23 μm.
Leg 6 not representeed by seta.
Color of living specimens unknown.

MALE. — Unknown.

ETYMOLOGY. — The specific name *tumidiseta*, from Latin *tumidus*, swollen, and *seta*, alludes to the swollen seta on the endopod of leg 4 and also to the swollen nature of certain setae on leg 1.

REMARKS

The new species is placed in the genus *Benthoxynus* Humes, 1984, where only one species, *Benthoxynus spiculifer* Humes, 1984, is thus far known, on the basis of several shared characters : (1) the caudal ramus with a minute innermost terminal seta, (2) the outer lobe of the first maxilla with four setae, (3) the inner coxal seta lacking in all four legs, (4) the outer margins of the endopodal segments of legs 1-3 smooth, (5) the outer spines on the exopodal segments of leg 1 setiform, (6) the formula for the third segment of the exopod of leg 4 as II,II,4, (7) the first segment of the endopod of leg 3 without an inner seta, (8) the endopod of leg 4 with 0-0 : 1, and (9) leg 5 a small lobe with 3 setae.

The different number of segments of the first antenna in the female of *B. spiculifer* (18) and *B. tumidiseta* (11) forms a striking contrast between the two species. However, a variable number of segments in the proximal part of the first antenna occurs in other dirivultid genera such as *Aphotopontius* and *Stygiopontius* (see HUMES, 1987 : 669, 702). For this reason, the difference in the number of segments in the first antenna of *B. spiculifer* and *B. tumidiseta* is not considered a generic distinction.

Females of *Benthoxynus tumidiseta* may be distinguished from those of *B. spiculifer* as follows :

	B. spiculifer	*B. tumidiseta*
Genital segment	slightly wider than long, 221 × 244 μm	slightly longer than wide, 253 × 242 μm
Caudal ramus, ratio of length to width	5 : 1	7 : 1
Terminal setae on second antenna	without lamella	with spiraling lamella
Distal part of maxilliped	with 3 setae	with 2 setae
Seta on endopod of leg 4	not swollen	swollen in proximal half

Ceuthoecetes aliger Humes and Dojiri, 1980

SPECIMENS EXAMINED. — 3 ♀♀, Totem, East Pacific Rise, 12°48.71′N, 103°56.53′W, "Nautile" dive no. 213, 07 November; 5 ♀♀, Totem, EPR, "Nautile" dive no. 212, 06 November; 1 ♀, Totem, EPR, "Nautile" dive no. 218, 12 November; 4 ♀♀, Genesis, EPR, 12°48.56′N, 103°56.48′W, "Nautile" dive no. 208, 10 November.

PREVIOUS DISTRIBUTION. — Galapagos Rift, East Pacific Rise at 21°N (HUMES, 1987; HUMES and DOJIRI, 1980).

Ceuthoecetes cristatus Humes, 1987

SPECIMENS EXAMINED. — 12 ♂♂, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November; 12 ♂♂, Totem, EPR, "Nautile" dive no. 212, 08 November; 4 ♂♂, Totem, EPR, "Nautile" dive no. 218, 12 November; 2 ♂♂, Totem, EPR, "Nautile" dive no. 229, 01 December; 21 ♂♂, Genesis, EPR, 12°48.56′ N, 103°65.48′ W, "Nautile" dive no. 208, 10 November.

PREVIOUS DISTRIBUTION. — Galapagos Rift (HUMES and DOJIRI, 1980); East Pacific Rise at 13° N and 21° N (HUMES, 1987).

Exrima dolichopus Humes, 1987

SPECIMENS EXAMINED. — 19 ♀♀, Genesis, East Pacific Rise, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 225, 27 November; 1 ♀, Parigo, EPR, 12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November.

PREVIOUS DISTRIBUTION. — East Pacific Rise at 13° N (HUMES, 1987).

Nilva torifera Humes, 1987

SPECIMENS EXAMINED. — 4 ♀♀, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 27 November; 1 ♂, Totem, EPR, "Nautile" dive no. 229, 01 December; 1 ♀, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November; 6 ♀♀, Genesis, EPR, "Nautile" dive no. 208, 10 November.

PREVIOUS DISTRIBUTION. — Galapagos Rift, East Pacific Rise at 13° N and 21° N (HUMES, 1987).

Rhogobius contractus Humes, 1987

SPECIMEN EXAMINED. — 1 ♂, Parigo, East Pacific Rise, 12°46.52′ N, 103°56.48′ W, "Nautile" dive no. 227, 29 November.

PREVIOUS DISTRIBUTION. — Galapagos Rift, East Pacific Rise at 13° N (HUMES, 1987).

Scotoecetes introrsus Humes, 1987

SPECIMENS EXAMINED. — 60 ♀♀, 10 ♂♂, Parigo, East Pacific Rise, 12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 210, 04 November; 1 ♀, Parigo, EPR, "Nautile" dive no. 227, 25 November; 77 ♀♀, 10 ♂♂, Elsa, EPR, 12°48.09′ N, 103°56.34′ W, "Nautile" dive no. 226, 28 November; 53 ♀♀, 32 ♂♂, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 224, 27 November; 5 ♀♀, 2 ♂♂, Genesis, EPR, "Nautile" dive no. 221, 22 November; 24 ♀♀, 8 ♂♂, Genesis, EPR, "Nautile" dive no. 216, 10 November; 1 ♀, Totem, EPR, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November.

PREVIOUS DISTRIBUTION. — East Pacific Rise at 13° N (HUMES, 1987).

Stygiopontius appositus Humes, 1989

SPECIMENS EXAMINED. — 2 ♂♂, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November; 3 ♂♂, Totem, EPR, "Nautile" dive no. 212, 06 November.

PREVIOUS DISTRIBUTION. — East Pacific Rise at 21° N (HUMES, 1989*a*).

Stygiopontius cinctiger Humes, 1987

SPECIMEN EXAMINED. — 1 ♀, Genesis, East Pacific Rise, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 221, 24 November.

PREVIOUS DISTRIBUTION. — East Pacific Rise at 21° N (HUMES, 1987).

Stygiopontius hispidulus Humes, 1987

SPECIMENS EXAMINED. — 9 ♀♀, Elsa, East Pacific Rise, 12°48.09′ N, 103°56.34′ W "Nautile" dive no. 226, 28 November; 15 ♀♀, Parigo, EPR, 12°48.52′ N, 103°56.48′ W, "Nautile "dive no. 210, 04 November; 54 ♀♀, Parigo, EPR, "Nautile" dive no. 211, 05 November; 18 ♀♀, Parigo, EPR, "Nautile" dive no. 223, 24 November; 10 ♀♀, Parigo, EPR, "Nautile" dive no. 227, 25 November; 26 ♀♀, Totem, EPR, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 09 November; 19 ♀♀, Totem, EPR, "Nautile" dive no. 215, 09 November; 3 ♀♀, Totem, EPR, "Nautile" dive no. 212, 08 November; 45 ♀♀, Totem, EPR, "Nautile" dive no. 218, 12 November; 1 ♀, Totem, EPR, "Nautile" dive no. 217, 11 November; 79 ♀♀, Julie, EPR, 12°48.96′ N, 103°56.62′ W, "Nautile" dive no. 203, 25 October; 72 ♀♀, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November; 92 ♀♀, Genesis, EPR, "Nautile" dive no. 216, 10 November; 68 ♀♀, Genesis, EPR, "Nautile" dive no. 222, 23 November.

PREVIOUS DISTRIBUTION. — East Pacific Rise at 13° N and 21° N (HUMES, 1987). (The listing of *S. hispidulus* at the Guaymas Basin (HUMES, 1987 : 781, 783) is an error; it has not been found at that location, although in all probability it occurs there.)

Stygiopontius sentifer Humes, 1987

SPECIMENS EXAMINED. — 10 ♀♀, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 213, 07 November; 7 ♀♀, Totem, EPR, "Nautile" dive no. 215, 09 November; 6 ♀♀, Totem, EPR, "Nautile" dive no. 218, 12 November; 1 ♀, Julie, EPR, 12°48.96′ N, 103°56.62′ W, "Nautile" dive no. 203, 25 October; 4 ♀♀, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November; 2 ♀♀, Genesis, EPR, "Nautile" dive no. 222, 23 November; 1 ♀, Parigo, EPR, 12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 223, 24 November.

PREVIOUS DISTRIBUTION. — East Pacific Rise at 13° N and 21° N (HUMES, 1987).

Stygiopontius stabilitus (Humes, 1989)

SPECIMENS EXAMINED. — 16 ♀♀, Totem, East Pacific Rise, 12°48.71′ N, 103°56.53′ W, "Nautile" dive no. 212, 06 November; 2 ♀♀, Totem, EPR, "Nautile" dive no. 218, 12 November; 50 ♀♀, Genesis, EPR, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 222, 23 November.

PREVIOUS DISTRIBUTION. — Mariana Back-Arc Basin, 18°13′ N, 144°42′ E (HUMES, in press).

Family Ecbathyriontidae Humes, 1987

Ecbathyrion prolixicauda Humes, 1987

Specimens examined. — 1 ♀, Genesis, East Pacific Rise, 12°48.56′ N, 103°56.48′ W, "Nautile" dive no. 221, 22 November; 1 ♀, Genesis, EPR, "Nautile" dive no. 222, 23 November; 1 ♀, Parigo, EPR,12°48.52′ N, 103°56.48′ W, "Nautile" dive no. 225, 27 November; 1 ♂, Parigo, EPR, "Nautile" dive no. 221, 22 November.

Previous distribution. — Galapagos Rift (Humes, 1987).

Range extensions

As a result of this study, the ranges of six species have been extended as follows :

Aphotopontius mammillatus : from the Galapagos Rift, the EPR at 21° N, and the Guaymas Basin to the EPR at 13° N;
Ceuthoecetes aliger : from the Galapagos Rift and the EPR at 21° N to the EPR at 13° N;
Stygiopontius appositus : from the EPR at 21° N to the EPR at 13° N;
Stygiopontius cinctiger : from the EPR at 21° N to the EPR at 13° N;
Stygiopontius stabilitus : from the Mariana Back-Arc Basin to the EPR at 13° N;
Ecbathyrion prolixicauda : from the Galapagos Rift to the EPR at 13° N.

The number of shared species at vents is now significant (Humes, 1987 : 783) and doubtless will increase with additional sampling (Grassle, 1986 : 341; Tunnicliffe, 1988 : 351).

Copepods found on the HYDRONAUT cruise at each of the five sites on the East Pacific Rise at 13° N

Elsa, 12°48.09′ N, 103°56.34′ W

Benthoxynus tumidiseta
Scotoecetes introrsus
Stygiopontius hispidulus

Genesis, 12°48.56′ N, 103°45.48′ W

Aphotopontius arcuatus, A. hydronauticus, A. mammillatus
Benthoxynus tumidiseta
Ceuthoecetes aliger, C. cristatus
Cheramomyzon abyssale
Ecbathyrion prolixicauda
Exrima dolichopus
Nilva torifera
Oncaea praeclara
Rhogobius contractus
Scotoecetes introrsus
Stygiopontius cinctiger, S. hispidulus, S. sentifer, S. stabilitus

Julie, 12°48.96′ N, 103°56.62′ W

Oncaea praeclara
Stygiopontius hispidulus, A. sentifer

Totem, 12°48.71′ N, 103°56.53′ W

Aphotopontius arcuatus, A. hydronauticus, A. mammillatus
Benthoxynus tumidiseta
Ceuthoecetes aliger, C. cristatus
Nilva torifera
Oncaea praeclara
Scotoecetes introrsus
Stygiopontius appositus, S. hispidulus, S. sentifer, S. stabilitus

Parigo, 12°48.52′ N, 103°56.48′ W

Benthoxynus tumidiseta
Cheramomyzon abyssale
Ecbathyrion prolixicauda
Exrima dolichopus
Oncaea praeclara
Rhogobius contractus
Scotoecetes introrsus
Stygiopontius hispidulus, S. sentifer

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